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D E C I S I O N
of 21 September 2004

Case Number: T 0637/02 - 3.4.2

Application Number: 99113716.7

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IPC: H01M 2/26

Language of the proceedings: EN

Title of invention:
Lithium secondary battery

Applicant:
NGK INSULATORS, LTD.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 52(1), 56

Keyword:
"Novelty: yes (multiple selection of parameters and materials)"
"Inventive step: no (definition of an invention by way of a correlation between parameters; the skilled person would obtain subject-matter falling under this definition by merely applying the teaching of a prior art document not disclosing this correlation)"

Decisions cited:
-

Catchword:
-



Case Number: T 0637/02 - 3.4.2

D E C I S I O N
of the Technical Board of Appeal 3.4.2
of 21 September 2004

Appellant: NGK INSULATORS, LTD.
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Decision under appeal: Decision of the Examining Division of the
European Patent Office posted 18 February 2002
refusing European application No. 99113716.7
pursuant to Article 97(1) EPC.

Composition of the Board:

Chairman: A. G. Klein
Members: M. P. Stock
J. H. P. Willems

Summary of Facts and Submissions

I. The applicant and appellant has appealed against the decision of the examining division refusing European patent application number 99 113 716.7 on the ground that it did not meet the requirements of Articles 56 and 84 EPC. The examining division reasoned that the subject-matter of claim 1 according to a main and three auxiliary requests then on file did not involve an inventive step and lacked essential features. Inter alia the following documents were cited:

D1: EP-A-0 822 605

D5: US-A-5 486 215

D6: G. Ceder and A. Van der Ven, MIT, "First Principles of Lighter, More Powerful Lithium Batteries" (cited by the appellant in the oral proceedings before the examining division and designated as "D2" in the minutes)

II. The appellant requested in his statement setting out the grounds of appeal that the decision be set aside and a patent be granted on the basis of claims according to a main request or a (first) auxiliary request. His arguments can be summarised as follows:

The present invention according to the main request aims at reducing the internal resistance in a lithium secondary battery. This is obtained by clarifying the correlation between certain parameters and basing a design rule thereon. Such a correlation is not disclosed in D1. Therefore the values provided by D1

are selected by the skilled person in a way that the longer the electrode is, the more current collecting tabs are provided. With the figures given in D1 and assuming a width of the electrode of 200 mm, a minimum value of 350 cm² for the average current collecting area would be obtained, which is beyond the range defined in claim 1. However, there is no teaching in D1 suggesting to take the current collecting area per tab into account, when trying to reduce the internal resistance. Rather the number of tabs is selected in D1 from the viewpoint of manufacture.

In addition, the present inventor has recognised that the increase of the number of tabs has only substantial influence if the resistance of the tabs plus that of the current collector is in the same order of magnitude as the resistance of the active material (LiMn₂O₄) of the electrodes. Thus the claimed selection of parameters is connected with the use of LiMn₂O₄. While in D1 LiMn₂O₄ is suggested, the appellant emphasises that LiMn₂O₄ has not made its way in mass production and, as is proven by D6, was considered not suitable due to instability at higher temperature. D6 obtained from the internet cites a reference of 1999 so that it should have been published thereafter, in particular after the priority date of the present application. Therefore it is concluded that the judgement regarding the poor usability of LiMn₂O₄ also applied at the priority date of the present application.

D1 lists all known materials which could be considered as active materials, but gives no specific technical instruction for embodying a battery based on LiMn₂O₄.

In contrast thereto the present invention is based on the recognition that not only the material LiMn_2O_4 is very suitable for obtaining a small internal resistance, but can be combined with the measure of increasing the number of tabs in order to further decrease the internal resistance. Thereby higher temperatures are avoided during use and the problem of instability of LiMn_2O_4 does not occur.

According to claim 1 of the (first) auxiliary request the micropores of the separator are lithium ion permeable. At a specific temperature, the micropores collapse and lose their ion permeability. Thereby the instability of LiMn_2O_4 at higher temperatures is avoided and any risk arising therefrom is banned. This is especially important for the use in passenger cars where the risk of fire due to overheating has to be avoided.

D5 discloses as a material for a separator "microporous polyolefin (i.e. polyethylene or polypropylene)". However, D5 does not disclose a three-layer structure. There is also no indication in D5 that the pores collapse at a certain temperature.

III. In preparation of the oral proceedings requested by the appellant, the Board made preliminary non-binding comments as to novelty and an inventive step of the subject-matter according to the main and (first) auxiliary request.

Since the appellant had contested that D5 disclosed a PP/PE/PP separator structure, the Board found it expedient to introduce a further document:

D7: EP-A-0 823 740

The Board stated that employing the terminology used in claim 1, document D7, see page 4, lines 15 to 28, and claim 13, discloses a separator for a Li battery, having a three-layer structure in which a polyethylene film having Li ion permeability and including micropores is sandwiched between porous polypropylene films having Li ion permeability.

As to the argument that according to a statement found in D6, LiMn_2O_4 has not been used in mass production because it was considered not suitable due to instability at higher temperatures, the board had noted that this document appeared to have been published only after the priority date of the present application as was admitted by the appellant, and hence did not by itself establish a technical prejudice, see Case Law of the Boards of Appeal, 4th edition, 2001, page 134, section 7.2, 2nd paragraph. If it were assumed that this judgement about LiMn_2O_4 was in fact common knowledge at the priority date, it didn't dissuade the inventor of D1 from considering this material anyway.

IV. As a reaction to the summons to attend oral proceedings the appellant filed a second auxiliary request.

Claim 1 according to the main request reads as follows:

"1. A lithium secondary battery, comprising:
an internal electrode body including a positive electrode with an active substance of lithium manganese oxide, a negative electrode with an active substance of

a carbonaceous material, and a separator, the positive electrode and the negative electrode being wound via the separator so that the positive electrode and the negative electrode are not brought into direct contact with each other, and an organic electrolyte;

wherein an average current collecting area obtained by dividing a positive electrode area (cm^2) by the number of current-collecting tabs to be attached to each of the positive and negative electrodes is 300 or less,

wherein the material of a current collecting body as an electrode substrate of the positive electrode is aluminum foil, and

wherein the material of a current collecting body as an electrode substrate of the negative electrode is copper foil."

Claim 1 according to the first auxiliary request reads as follows:

"1. A lithium secondary battery, comprising:

an internal electrode body including a positive electrode with an active substance of lithium manganese oxide, a negative electrode with an active substance of a carbonaceous material, and a separator, the positive electrode and the negative electrode being wound via the separator so that the positive electrode and the negative electrode are not brought into direct contact with each other, and an organic electrolyte;

wherein an average current collecting area obtained by dividing a positive electrode area (cm^2) by the number of current-collecting tabs to be attached to each of the positive and negative electrodes is 300 or less,

wherein the material of a current collecting body as an electrode substrate of the positive electrode is aluminum foil,

wherein the material of a current collecting body as an electrode substrate of the negative electrode is copper foil, and

wherein the separator has a three-layer structure in which a polyethylene film having lithium ion permeability and including micropores is sandwiched between porous polypropylene films having lithium ion permeability."

Claim 1 according to the second auxiliary request reads as follows:

"1. A method for producing a lithium secondary battery having a capacity of 5 Ah or more with a lower internal resistance, said battery comprising: an internal electrode body including a positive electrode with an active substance of lithium manganese oxide, a negative electrode with an active substance of a carbonaceous material, and a separator, the positive electrode and the negative electrode being wound via the separator so that the positive electrode and the negative electrode are not brought into direct contact with each other, and an organic electrolyte; wherein the material of a current collecting body as an electrode substrate of the positive electrode is aluminum foil and the material of a current collecting body as an electrode substrate of the negative electrode is copper foil;

said method being characterized by the steps of:

preparing electrodes having such a predetermined length and width, and

forming such a predetermined number of tabs thereon that

a division of a positive electrode area (cm^2) by the number of current-collecting tabs to be attached to each of the positive and negative electrodes results in an average current collecting area being 300 or less, and

a division of the number of current collecting tabs to be attached to each of the positive and negative electrodes by the width (mm) of the positive electrode results in a value (tab/width ratio) being greater than 0.1."

- V. Oral proceedings took place on 21 September 2004. At the oral proceedings the appellant requested that a patent be granted on the basis of the claims according to the main request or alternatively according to the first or second auxiliary request. At the end of the oral proceedings the Board gave its decision.

Reasons for the Decision

1. The appeal is admissible.
2. *Novelty*
 - 2.1 Using the terminology employed in claim 1 according to the main request, document D1, see Figures 1 to 4 and 7 and column 5, line 44 to column 8, line 15, discloses a lithium secondary battery, comprising an internal electrode body 5 including a positive electrode 12 with an active substance 3, a negative electrode 11 with an active substance, and a separator (mentioned in the

text, but not shown in the figures), the positive electrode and the negative electrode being wound via the separator so that the positive electrode and the negative electrode are not brought into direct contact with each other, and an organic (which is implicit) electrolyte, wherein a number of current-collecting tabs 4 and 4' are attached to each of the negative and positive electrode 11 and 12, respectively.

2.2 According to D1, see column 4, lines 38 to 57, the active substance of the positive electrode is capable of inserting Li and is selected from various transition metal compounds, e.g. Li-containing metal oxides selected from the oxides of Co, Ni, Mn, V, Fe and Ti, and the material of the of the current collecting body is selected from Al and stainless steel, the thickness being less than 50 μm . Thus a person skilled in the art had to select from the variety disclosed in D1 a positive electrode with an active substance of lithium manganese oxide (LiMn_2O_4) and a substrate made of Al foil in order to obtain the subject-matter of claim 1 according to the main request.

2.3 According to D1, see column 4, line 58 to column 5, line 9, the active substance of the negative electrode e.g. is a carbonaceous material ("matériau carboné") and the material of the current collecting body is selected from Cu and Ni, the thickness being less than 50 μm . Hence, for the subject-matter of claim 1 according to the main request the skilled person had to select Cu foil for the substrate of the negative electrode.

2.4 It is indicated in D1, see column 3, lines 16 to 26, that according to examples, the length (designated as B in the present application) of the electrode is between 3 and 7 m, the distance between tabs (tab pitch B/D) is between 60 and 300 mm and the number of tabs is between 15 and 40. No figure for the width of the electrodes is indicated in D1. However, for a width (C) of less than 50 cm and the given figures for the tab pitch, e.g. B/D = 6 cm, values of the current collecting area $B \times C/D$ or $B/D \times C$ can be calculated which are less than 300 cm^2 .

2.5 It turns out that the skilled person had to carry out a multiple selection of materials and parameters out of a variety of materials and from a broad range, respectively, disclosed in D1, i.e. the active material LiMn_2O_4 for the positive electrode, Al foil for the substrate of the positive electrode, Cu foil for the substrate of the negative electrode and a current collecting area which is 300 cm^2 or less, in order to arrive at the subject-matter of claim 1 according to the main request. Such a multiple selection establishes novelty in the claimed subject-matter, see Case Law of the Boards of Appeal, 4th edition 2001, paragraph 4.2.3 at page 83.

3. *Inventive step*

3.1 The subject-matter of claim 1 according to the main request differs from the prior art according to D1 by the selection of materials and parameters as outlined above. The selection of LiMn_2O_4 would have been non-obvious to the skilled person if it had turned out that this material is particularly well suited for a lithium secondary battery, unexpectedly more suited than the

other materials mentioned in D1. There is no proof for this neither in the application nor in the submissions provided by the appellant during the examination or appeal procedure. On the contrary, in the application it is stated (see A-document, in paragraph [0018] at page 3): The positive electroactive material "is not particularly limited, there is preferably used a lithium transition metal compound oxide, such as LiCoO_2 , LiNiO_2 , LiMn_2O_4 or the like." There was no proof either that there was a prejudice against the use of LiMn_2O_4 at the priority date of the present application, see point III above.

3.2 As to the materials for the electrode substrates, the selection of one from only two materials offered in D1 for each electrode, see points 2.2 and 2.3, could be effected by the skilled person without exercising any inventive activity. If necessary, simple experiments could have confirmed the suitability of the claimed choice.

3.3 Concerning the current collecting area ($B \times C/D$) which is defined in the present application and the upper limit of which is indicated in claim 1, it is stated that establishing a new parameter reflecting a certain correlation between the length and width of the electrodes and the number of tabs does not per se involve an inventive step. It is only the technical teaching based on this correlation, which has to be investigated as to whether it leads to different results than the teaching of the prior art, and as to whether this teaching was non-obvious. In the present case, the problem to be solved is directed to reducing

the internal resistance of the lithium secondary battery.

- 3.4 A corresponding problem is mentioned in D1, see column 1, lines 37 to 42, namely, to provide a lithium secondary battery having a high capacity and a high power. The skilled person knows that the power available from a battery depends upon its internal resistance. The measures taken in D1 in order to solve the problem include the selection of the number of tabs and the distance between them, see column 3, lines 16 to 26. It was clear to the skilled person that the internal resistance is partly caused by the connection of each electrode and could be lowered by increasing the number of tabs providing this connection. As was shown under point 2.4 above, merely using the information available from D1 in conjunction with a reasonable electrode width already achieves figures of the current collecting area falling within the claimed range of 300 cm² or less. Such figures were therefore obvious.

4. *Arguments of the appellant*

- 4.1 The appellant argued that the main teaching of D1 according to claims 1 and 17, the abstract, the summary of the invention and Figure 4 was more concerned with the upper cover of the battery, and less with the inner part, i.e. the substrate and the tabs. D1 represented a "shotgun disclosure" in the sense that it tried to cover a large field. Claims 1 and 17 in agreement with the corresponding parts of the description were directed to two distinct embodiments whose features were not interchangeable for the purpose of an

anticipating disclosure. Therefore the features related to the mechanical dimensions of the electrodes and tabs disclosed in the framework of the first embodiment were not connected with the material-related features of the second embodiment. The claims in D1 were not consistent with the description. For instance, Claim 11 defined the length of the electrode as being greater than 2 m, whereas according to the description this length exceeded 2 m, even 5 m, and was e.g. between 3 and 7 m. According to claim 12 the number of tabs was greater than 3 whereas according to the description, the distance between two tabs was between 60 and 300 mm, the number of tabs was greater than 3, could even be greater than 10 or even 30, and was e.g. between 15 and 40. There was no disclosure in D1 of a figure for the width of the electrodes. The existence of a standard width was contested.

4.2 However, these arguments are not found convincing by the Board. The intention pursued by the authors of D1 is of secondary importance. Of primary importance is what the skilled reader actually derives from the document in terms of technical information. Therefore the emphasis put in D1 on the terminals does not disguise the disclosure related to the electrodes and connecting tabs. It is also clear to the skilled reader that the battery described in D1 with respect to the figures from line 44 of column 5 onwards may have electrodes of the special dimensions and materials indicated in the general part of the description, column 4, line 38 to column 5, line 9. In any case, the skilled person would obviously consider any suitable combination of parameters and materials. The stepwise narrowing of ranges in the description is not in

contradiction with the broader claiming. The lack of an explicit indication of a width in D1 poses no problem to the skilled person, since any reasonable figure would meet the requirement of present claim 1, see point 2.4 above.

4.3 The appellant further argued that the invention according to the present application was specifically directed to the use of LiMn_2O_4 as electroactive material. This was clear from paragraph [0022] of the A-document of the present application, where a link was made between the invention in general and the material shown in Table 1, which was LiMn_2O_4 . The invention was based on the fact that the resistance of the material LiMn_2O_4 was of the same order of magnitude as the remaining resistance contributing to the internal resistance of the battery.

4.4 This argument which is not supported by experimental evidence is also not found convincing by the Board. Paragraph [0022] of the present application cited by the appellant is placed in the part "Detailed Description of the Invention", which is usually related to embodiments, and not in "Summary of the Invention", related to the invention in general. Therefore the skilled reader would conclude that LiMn_2O_4 indicated in Table 1 is just an example of the materials indicated in paragraph [0018] at page 3. If a special relationship between the resistance of the material and the remaining resistance were derivable from Table 2, there would be no indication that this would be substantially different for the other materials recited in paragraph [0018]. The Board is therefore of the

opinion that there is no proof for any unexpected effect connected with the selection of LiMn_2O_4 .

5. *Auxiliary requests*

5.1 Claim 1 according to the first auxiliary request contains in addition a feature related to a three-layer structure of the separator, in which a polyethylene film having lithium ion permeability and including micropores is sandwiched between porous polypropylene films having lithium ion permeability. A separator having such a three-layer structure for use in a lithium secondary battery is described in D7, see point III above, so that its incorporation in the battery of document D1 is considered obvious to the skilled person.

5.2 The claims according to the second auxiliary request are directed to methods of producing a lithium secondary battery which is further specified as having a capacity of 5 Ah or more with a lower internal resistance. Claim 1 also includes the features of claims 1 and 3 according to the main request, reformulated in terms of a method. Since the method defined in claim 1 does not comprise any particular manufacturing or sequence of steps, no new argumentation as to lack of an inventive step is necessary, except for the added features. For those the following is stated: a capacity falling within the range of more than 5 Ah is already disclosed in D1, see column 1, lines 40 to 45. The requirement of higher power indicated at the same location in D1 is equivalent to a lower internal resistance. The number of tabs divided by the electrode width in mm (tab/width

ratio: D/C) of greater than 0.1 is obtained in D1 for the selection of 40 tabs (see column 3, line 22 to 26) and a width falling in the range of less than 400 mm, which would correspond to any reasonable width considered by the skilled person.

- 5.3 The appellant put forward the argument that D1 did not disclose any method of producing a battery. However, this can not be accepted by the Board because such a method implicitly disclosed by reference to the features related to the device shown in D1, in the same manner as the claimed method was formulated on the basis of the device disclosed in the present application.

6. *Conclusion*

Therefore taking into due account the arguments of the appellant the Board reached the conclusion that the present application does not meet the requirements of Article 52(1) EPC because the subject-matter of claim 1 according to a main, first auxiliary and second auxiliary request does not involve an inventive step in the meaning of Article 56 EPC.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar:

The Chairman:

P. Martorana

A. G. Klein